EFFECT OF FLY ASH AS PARTIAL CEMENT REPLACEMENT ON WORKABILITY AND STRENGTH ON WATER CURED LIGHTWEIGHT CONCRETE

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of B. Eng (Hons) Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Abu terbang yang dihasilkan dari loji kuasa arang batu dilupuskan sebagai sisa pencemaran alam sekitar. Penggunaan simen dalam pembinaan menyebabkan pelepasan gas rumah hijau yang dihasilkan daripada pengeluaran simen. Ia juga bukan persekitaran yang mesra alam dan mahal untuk pembinaan di era ini. Di samping itu, batu dandang minyak kelapa sawit merupakan hasil sampingan sampah pengilangan minyak sawit yang menyebabkan peningkatan kawasan pembuangan sampah. Dalam kajian ini, kajian ini menyiasat kesan abu terbang sebagai penggantian simen separa pada kebolehkerjaan, kekuatan mampatan dan lentur pada air konkrit ringan sembuh. Lima jenis campuran dengan pelbagai peratusan abu terbang sebagai kandungan penggantian simen separa digunakan. Campuran pertama ialah 0% daripada tindakan abu terbang sebagai spesimen kawalan dan yang lain mengandungi 10%, 20%, 30% dan 40% kandungan abu terbang. Kekuatan mampatan dan kekuatan lentur ditentukan pada 7, 14 dan 28 hari. Penemuan menunjukkan kekuatan meningkat apabila peratusan abu terbang meningkat. Kekuatan mampatan tertinggi ialah 10% abu terbang yang digunakan dalam konkrit. Trend yang sama diperhatikan dalam keputusan lenturan. Abu terbang menjadi bahan pozzolanic menyebabkan reaksi pozzolanic dalam campuran konkrit yang meningkatkan jumlah C-S-H gel. Akibatnya, konkrit menjadi lebih padat dan lebih kuat.

ABSTRACT

Fly ash generated from coal power plant is disposed as environmental polluting waste. The use of cement in construction cause the greenhouse gas emission that produces from the cement production. It is also not eco-friendly environment and costly for construction in this era. In addition, palm oil boiler stone is a waste by-product of palm oil milling that causes the increasing of dumping area. In this study, this research investigates the effect of fly ash as partial cement replacement on workability, compressive strength and flexural on water cured lightweight concrete. Five types of mixes with various percentage of fly ash as partial cement replacement content were used. The first mixes are 0% of fly ash act as control specimen and the others contains 10%, 20%, 30% and 40% of fly ash content. The compressive strength and flexural strength were determined at 7, 14 and 28 days. Findings show that strength is increasing as a percentage of fly ash used increase. The highest compressive strength is 10% of fly ash used in concrete. Similar trend were observed in flexural strength result. Fly ash being a pozzolanic material causes pozzolanic reaction in concrete mix which increases amount of total C-S-H gel. As a result, the concrete become denser and stronger.

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LIST OF SYMBOLS

kg	Kilogram
m^3	Meter
MPa	Mega pascal
%	Percentage

LIST OF ABBREVIATIONS

LWC	Lightweight Concrete
LWAC	Lightweight Aggregate Concrete
POBS	Palm Oil Boiler Stone
OPC	Ordinary Portland Cement
OPEFB	Oil Palm Empty Fruit Bunches
OPS	Oil Palm Shell

CHAPTER 1

INTRODUCTION

1.1 Introduction

Lightweight concrete (LWC) is a special concrete which weigh lighter than conventional concrete. There are three types of LWC, which are lightweight aggregate concrete, aerated concrete, and no-fines concrete. LWC has a lower modulus of elasticity, higher inelastic strains and lower coefficient of thermal expansion. In addition, LWC has more continuous contact zone between the aggregate and the paste, and more water in the pores of aggregate for continued internal curing when compared to normal weight concrete. LWC has lower thermal expansion than ordinary concrete and can reduce the cost of material used for construction.

Malaysia is one of the largest producers and exporters of palm oil products to various corners of the world (Kanadasan, 2014). One of the top product is Palm Oil Boiler Stone (POBS) act as LWC. The processing phase of palm oil products accumulate too much causes the disposal site to be limited. POBS was obtained from the by-product of palm oil milling (Bashar, 2014) and a waste by-product from the incineration process of oil palm shells and fibers (Mohammed, 2011). The waste product such as POBS causes pollutions such as air pollution during the milling stage of palm oil production and land pollution where the dumping of palm oil boiler stone has increase the degradation of land. Utilization of POBS in concrete production did not only solves the problem of solid waste disposal but also helps to conserve natural resources (Bashar, 2014).

Another waste product that comes from coal industry is fly ash which is a fine powder that is a by-product of burned pulverized coal in the electric generation power plant. The ash contains aluminous and siliceous materials will form the same compound with Portland cement if added with water and lime. Improve workability, contribute to

strength development and hence consider an effective cementitious component of concrete found in fly ash (Islam, 2010). The use of fly ash as an eco-friendly product as a by-product produces low energy. The benefits of using fly ash are to reduce the problems of cracking, permeability and bleeding. It also can be a cost-effective replacement for Portland cement because it may reduce the amount of cement when fly ash added to concrete. Finally, it gives benefits for our environment.

1.2 Problem Statement

Due to the growing of economy with fast development in this era, the usage of cement is increasing. Increasing usage of large quantities of cement may cause problems to the consumers. Cement is a broad energy commodity industry and leads to the release of large amounts of greenhouse gases (Chowdhury, 2015). Fly ash is also a waste product that produces from coal industry that causes air pollution. In addition, palm oil boiler stone (POBS) is also a waste from palm oil mill industry. The dumping of palm oil boiler stone has increased the degradation of land and affecting groundwater sources.

1.3 Objective of Study

The objective of the study is as follow:

a) To investigate the effect of fly ash as partial cement replacement on the workability of Palm Oil Boiler Stone lightweight aggregate concrete.

b) To investigate the effect of fly ash as partial cement replacement on compressive strength of Palm Oil Boiler Stone lightweight aggregate concrete.

c) To investigate the effect of using the different percentage of fly ash as partial cement replacement towards the flexural strength of Palm Oil Boiler Stone lightweight aggregate concrete.

1.4 Scope of Research

This test is conducted to determine the effect of fly ash as partial cement replacement towards workability and strength of lightweight concrete. In this thesis, there

are five samples of mix that were casted, which were 0% that act as a control concrete specimen, 10%, 20%, 30% and 40% of fly ash as a substitute for the cement. The difference percentage of fly ash as partial cement replacement was to investigate the strength of concrete. There is two type of specimens conducted for curing regime namely beam that was conducted to test flexural strength and cube that was conducted to test compressive strength of concrete. In addition, slump test was conducted to test the workability of the concrete. To get the accurate result, the test will be repeated three times and within 28 days.

1.5 Significance of Research

Utilization of fly ash as partial cement replacement has many significant environmental benefits. Fly ash use conserves natural resources and materials. Use of fly ash can avoid landfill disposal. The use of fly ash as a substitute for cement also reduces air pollution. Meanwhile, the use of palm oil boiler stone (POBS) can also help to reduce the use of landfill that affects the groundwater sources. This can keep the groundwater sources safe.

1.6 Layout of Thesis

This report consists of five chapters. Chapter one introduces the issue investigated in this research highlighting problem statements and outlining objective to be achieved. The scope of research and contribution of the study is also included in this section. The chapter ends with the layout of the thesis. Chapter two discusses the utilization of POBS and fly ash in concrete production. This includes the review of basic properties and application of LWAC. Define the workability and strength of concrete and the review of these issues presented in this chapter.

Chapter three discusses the methodologies used in this study. In this section reported the preparation of mix ingredients and the apparatus used in conducting the experiment. The detail explanation about design mix of the concrete will present in this chapter. In chapter three also discuss the testing procedure adopted. Chapter four mainly presents and discusses the laboratory results of POBS lightweight aggregate concrete incorporated with fly ash. Data that has been analysing and form of graph for workability and strength test result are present in this chapter.

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